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ABSTRACT

Some of the changes in various aspects of CAI activity over the period 1970-76 are discussed in the context of descriptive data, in an attempt to provide a broader and more analytic view. The data derives from the 1970, 1973, and 1976 editions of the "Index to Computer Based Learning," published by the Instructional Media Laboratory of the University of Wisconsin. Tables include summary statistics for 1970-76; average student completion times; and total number of programs by central processor, source, subject matter, instructional strategy, and language. (VT)

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RIR-76-5

SOME "FACTS" ABOUT CAI: TRENDS 1970-1976

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TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC) AND USERS OF THE ERIC SYSTEM."

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ABSTRACT

Descriptive data on various aspects of CAI activity over the period 1970-1976 are presented. This includes trends in subject matter, author languages, central processors, instructional strategies, length of courses and sources of programs.

Activity in the field of Computer Assisted Instruction (CAI) began in earnest about 1960 with a few pilot projects. By the end of the decade, CAI had established itself as a viable instructional medium. Even though the history of CAI spans only 16 years, a number of significant changes have occurred . This paper discusses some of these changes in the context of descriptive data on various aspects of CAI activity in the six year period 1970-1976. While this period is relatively short in terms of historical analysis, in view of the very rapid pace in both computer and educational technologies it is sufficiently long to detect certain developments in the CAI domain.

Most discussions of developments in CAI take the form of qualitative remarks based upon surveys or case studies of particular CAI projects. While such discussions are highly valuable, they are necessarily selective. The present study is an attempt to provide a broader and more analytic view of changes in CAI activity by means of quantitative descriptive analysis.

The data derives from the 1970, 1973, and 1976 editions of the Index to Computer Based Learning (Lekan, 1970; Hoye & Wang, 1973; Wang, 1976) published under the auspices of the Instructional Media Laboratory of the University of Wisconsin. These Indexes are part of a continuing effort to maintain an up-to-date resource catalogue of available CAI programs. Each program listed in an Index provides information on variables such as the source, level of

instruction, author language, funding agency, etc. This information was acquired via a questionnaire distributed to CAI centers throughout the world. While these Indexes are designed as a guide to available CAI courseware, they also provide a comprehensive and systematic documentation of CAI activity. In fact, this source is probably the most complete CAI documentation which is publicly available. For this reason, it can be considered a reasonably good reflection of activity in the entire CAI domain.

However, it must be emphasized that these Indexes provide only one sampling source (hopefully representative) and hence involve certain inherent biases and error. Since the data for the Indexes was acquired on a voluntary basis without independent verification, there are bound to be some inaccuracies, omissions, exaggeration, etc. Furthermore, the questionnaires provided no guidance regarding the exact nature of the various categories, leaving this instead to the interpretation of the respondent. Since different respondents are likely to categorize things somewhat differently (e.g., what constitutes an inquiry versus socratic instructional strategy), error is introduced. In addition, no guidance was provided regarding inclusion or deletion of past (and possibly defunct) programs. For these reasons (and others which will be mentioned at the appropriate places), the following data and its

interpretation should be viewed with care.[1]

General Trends.

Some general summary statistics are given in Table 1.

Insert Table 1 here.

Lekan (1970, p. ix) estimated that there were fewer than 100 CAI programs available in 1967. As Table 1 shows, the number of programs available grew quite rapidly from 1967 to 1973, rising to 910 in 1970 and 1766 by 1973. However, in the 1973-1976 period this rapid development apparently subsided since the increase in this three year period was only from 1766 to 1837 programs. Of the programs listed in the 1970 Index , approximately 55% of these were still listed in the 1973 Index , and 19% in the 1976 Index. Thus while the total number of programs for 1970-1976 showed a leveling off, this is partly due to the weeding out or consolidation of earlier programs and may also be due to a sampling limitation in the 1976 Index.

The total number of subjects available has increased steadily over the six year period indicating that the range and diversity of CAI subject matter has continued to broaden. In 1976 this included subjects such as agronomy,

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1. These remarks are not intended to demean the value of the Indexes as resource catalogues (for they are excellent) but rather to point out their limitations as data sources for this particular study.

cinema studies, driver education, ecology, graphic arts, journalism, nuclear warfare, psycholinguistics, urban planning and 14 different foreign languages.

The total number of sources has also increased consistently between 1970 and 1976 indicating that CAI involvement by new institutions is still occurring. The total number of author languages, however, show an increase between 1970 and 1973 but a decrease between 1973 and 1976. This suggests that more attention is now being paid to existing languages rather than the development of new languages. It also may reflect an attrition of some special-purpose CAI languages which are now derilect. With respect to central processors, the increase in the number of different types of machines in use has continued throughout the 1970-1976 period. The decrease in the number of programming languages in use coupled with the increase in number of different types of central processors may indicate a tendency towards the use of general purpose programming languages.

Table 2 indicates the number of programs having average student completion times in the specified ranges.

Insert Table 2 here.

In 1970 and 1973, the majority of programs were less than an hour in average duration whereas in 1976 the majority were

in the 1-10 hour range.[2] Furthermore, the number of programs of longer durations increased steadily over this period. The number of programs with durations longer than 10 hours was 5.6% in 1970, 7.5% in 1973, and 11.7% in 1976. Thus, there has been a general shift towards CAI programs of longer duration. This trend may reflect the weeding out or consolidation of shorter programs and perhaps a transition from CAI programs which were largely demonstration to programs intended to serve as more major instructional components.

The general picture presented by this summary data is one of continued activity in the CAI field as gauged by the increasing number of programs and sources. CAI activity appears to have passed through an initial period of rapid growth and reached a stage of sustained development. This conclusion is supported by the decreasing proliferation of author languages in use and the general shift in the average program completion times.

Specific Trends.

Turning to a more detailed analysis, consider first the trends in the total number of programs according to subject matter. The 10 most frequent subject matters for each of the three years are shown in Figure 1.

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2. This data is based only on the programs which listed an average completion time. This constituted 66%, 80%, and 57% of all programs listed for 1970, 1973, and 1976, respectively.

Insert Figure 1 here.

As the figure shows, the largest number of programs in all three years were devoted to mathematics (including statistics, arithmetic, calculus, algebra, and geometry). In 1970 and 1973, computer operations and programming, health professions and chemistry were the next most frequent. In 1975, however, the health professions had far more programs than either chemistry or computer-related topics. Furthermore, the number of programs in the health professions subject domain continued to increase over the six year period but decreased in the subject domains of chemistry, computer operations & programming, and physics. Biological sciences also increased in total number of programs over the six year period. This data indicates that the health professions have increasingly accepted CAI as a useful instructional medium. It should be noted that in terms of another measure of frequency (i.e., total number of hours of available instruction or average completion times), the relative importance of the different subject matters would change.[3]

Figure 2 presents the total number of programs in terms of the 10 most frequent instructional strategies. Note that

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3. For example, an in-depth analysis of 1976 (Kearsley, 1976) shows that in terms of total average completion times, foreign language programs rank first, followed by health professions and mathematics.

instructional strategies are not exclusive and hence all strategies listed for each program have been tabulated.

Insert Figure 2 here.

First of all, it can be seen that the tutorial mode of instruction dominated the types of strategies used in 1970 and 1973 but that a drill & test strategy was most frequent in 1976. This is a little surprising in that one would expect a tutorial strategy to become more frequent as programs become longer. This result may suggest that drill & test has turned out to be the most effective CAI strategy (e.g., Keene, 1968). Simulation and problem-solving strategies are also more frequent in 1976 than in previous years. Although advocates of generative CAI (e.g., Uttal, 1970; McMullen, 1974) have presented sound arguments for the use of inquiry or socratic strategies, there seems to be no strong trend towards the use of these instructional strategies.

The total number of programs according to author language are shown in Figure 3 for 1970, 1973, and 1976.

Insert Figure 3 here.

In terms of total number of programs, COURSEWRITER was the most frequent language in 1970 and 1973, however, it declined to fourth most frequent in 1976. APL and TUTOR show steady increases through the 1970-1976 period with APL being

the most frequent CAI language in 1976. It should be pointed out that the rapid increase in the use of APL is due to the CAI project of Coast Community College. About 80% of the APL programs in 1976 orginated from this source. The number of BASIC and FORTRAN programs increased in 1970-1973, but decreased in the 1973-1976 period.

In terms of the number of different sources using the same author language, BASIC is the most widely used language. TUTOR is restricted to the users of the PLATO system originating from the University of Illinois. It is interesting to note that the three general purpose languages APL, BASIC, and FORTRAN have been as well used for CAI purposes as the special purpose CAI languages COURSEWRITER and TUTOR.

The 10 most frequently used CPU's are listed in Table 3 for each of the three years ranked by the number of programs.

Insert Table 3 here.

In 1970, the IBM 1130/1500/1800 instructional system was the most frequently used CPU followed by the CDC 1604 (used for the PLATO system). The IBM 1410/1440, IBM 360 , and IBM 7000 series were next most frequent. It is clear that IBM's specialized instructional systems dominated the early phase of CAI hardware (along with COURSEWRITER as an author language). In 1973, the general purpose 360/370 had the

largest number of programs followed by the IBM 1130/1500 /1800 system. In 1973, the PLATO system was running on both CDC 1604's and 3000/6000 series computers. A number of small computers (PDP's and TSS-8) were in use in 1973. In 1976, the IBM 370 (particularly the 370/155) had by far the largest number of CAI programs, followed by the CDC Cyber (the PLATO system). The IBM 1130/1500/1800 hardware dropped to fourth most frequent in 1976 reflecting its fading obsolescence. Hewlett-Packard, PDP and DEC 10/1000 CPU's ranked 3rd, 5th, and 7th in 1976, indicating the increasing use of small to medium machines.

The total number of programs according to originating source are given in Table 4.

Insert Table 4 here.

In 1970, the University of Illinois (the PLATO system) had the largest number of programs, followed by Pennsylvania State University, the University of Texas at Austin, and Florida State University (the latter three using IBM 1500 systems). In 1973, the University of Illinois still had the largest number of programs, followed by Coast Community Colleges; however, in 1976, Coast Community Colleges have far more programs avilable than the University of Illinois. Two european sources, Forschungszentrum fur Rehabilitation und Pravention (F.R.P.), Hiedelberg, and the University of Leeds were among the 10 most frequent sources in 1976 possibly relecting the development of more vigourous CAI

activity outside North America.

A notable feature of Table 5 is the relatively high number of changes in the status of sources. In part this reflects a lack of consistency in the data reporting procedures. However, it also reflects the short half-life of CAI projects. Of the 82 sources listed in the 1970 Index , only 57 (80%) were still listed in the 1973 Index and 36 (44%) in the 1976 Index. This is due in no small way to the general lack of long-term and dependable sources of funding for CAI research and development, and specifically to university budget cutbacks in the early seventies.

Summary & Conclusions.

The preceding data reflects the following trends in the development of CAI in the period 1970-1976:

1. An increase in the range of subjects offered via CAI. Programs in the subject area of the health professions have shown the greatest increase over the period. Mathematics continuues to be the subject matter with the largest number of programs devoted to it.
2. The number of different author languages in use appears to have increased from 1970-1973 and decreased from 1973-1976. This suggests that the development of new author languages has waned and most CAI programming is being done in the existing CAI author languages or general purpose languages such as APL or BASIC.
3. In contrast to author languages, the general trend for

central processors involves a consistent increase in the number of types of CPU's in use for CAI activity. In 1970, the dominant CPU in use was the IBM 1130/1500/1800 instructional system, however, in 1976, the general purpose IBM 370 was most frequently used.

5. The usage of instructional strategies have not changed significantly over the period except for the more frequent use of a drill & test strategy in 1976. These data show no major increase in the use of the inquiry or socratic strategies over this period.
6. The number of sources involved in writing CAI programs continued to increase over the entire period. With the exception of the University of Illinois (and its PLATO system), no source has remained a major developer of CAI courseware for the entire six year period.
7. The general distribution of average program completion times has shifted towards longer durations over the six year period. Thus, while the average program length was less than an hour in 1970, in 1975, it was in the 1-10 hour range. In addition, programs longer than 10 hours were more frequent in 1976.

There are numerous other variables of interest which have not been analyzed but which undoubtedly reflect interesting trends. For example, no analysis was made of changes in the levels or type of instruction over this period. It might be expected that there would be an increased tendency towards elementary or secondary instruction or perhaps an increase in the proportion of

vocational training given via CAI. Nor was there any analysis of instructional logics, program availability, funding, etc., all of which might be expected to show significant changes over the period studied. In addition to the analysis of these other measures, more adequate and complete analyses would benefit from a more comprehensive sampling method (which encompassed CAI activity in industry and public/secondary school systems) and more accurate reporting of measures such as total available instructional hours, average student completion time, and total number of completed terminal hours.

It is well known that success in CAI depends upon a blending of economics, curriculum design, and computer technology. While the present data do not reveal anything about the cost or quality of instruction, they do show the inter-relationships between curriculum (subject matters, instructional strategies) and computer technology (languages, CPU's). Even though the data are inadequate in a number of respects, they serve to illustrate the need for and the value of descriptive analysis of trends in CAI development.

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TABLE 1

Summary Statistics for 1970-1976.

	1970	1973	1976
Total Programs Available	910	1766	1837
Total Subjects Available	53	98	137
Total Number of Sources	82	185	219
Total Author Languages	60	93	76
Total Central Processors	54	98	116

TABLE 2

Average Student Completion Times.

	Number of Programs		
Hours	1970	1973	1976
< 1	288	769	396
1-10	281	563	525
11-20	19	35	46
21-30	5	18	24
31-40	1	7	11
41-50	1	11	16
50-100	1	8	19
>100	7	8	6

FIGURE 1. TOTAL PROGRAMS BY SUBJECT MATTER.

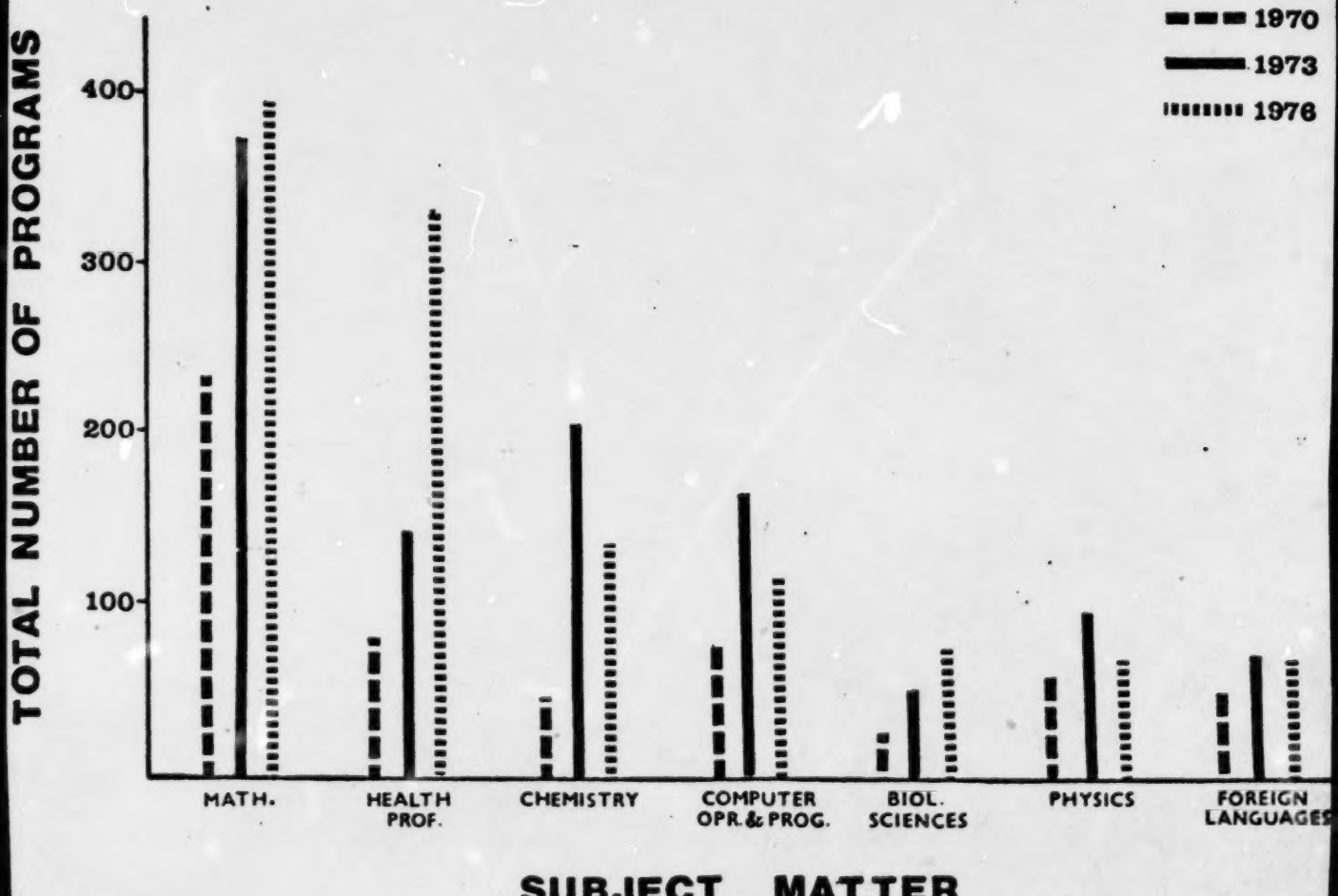

FIGURE 3. TOTAL PROGRAMS BY AUTHOR LANGUAGE.

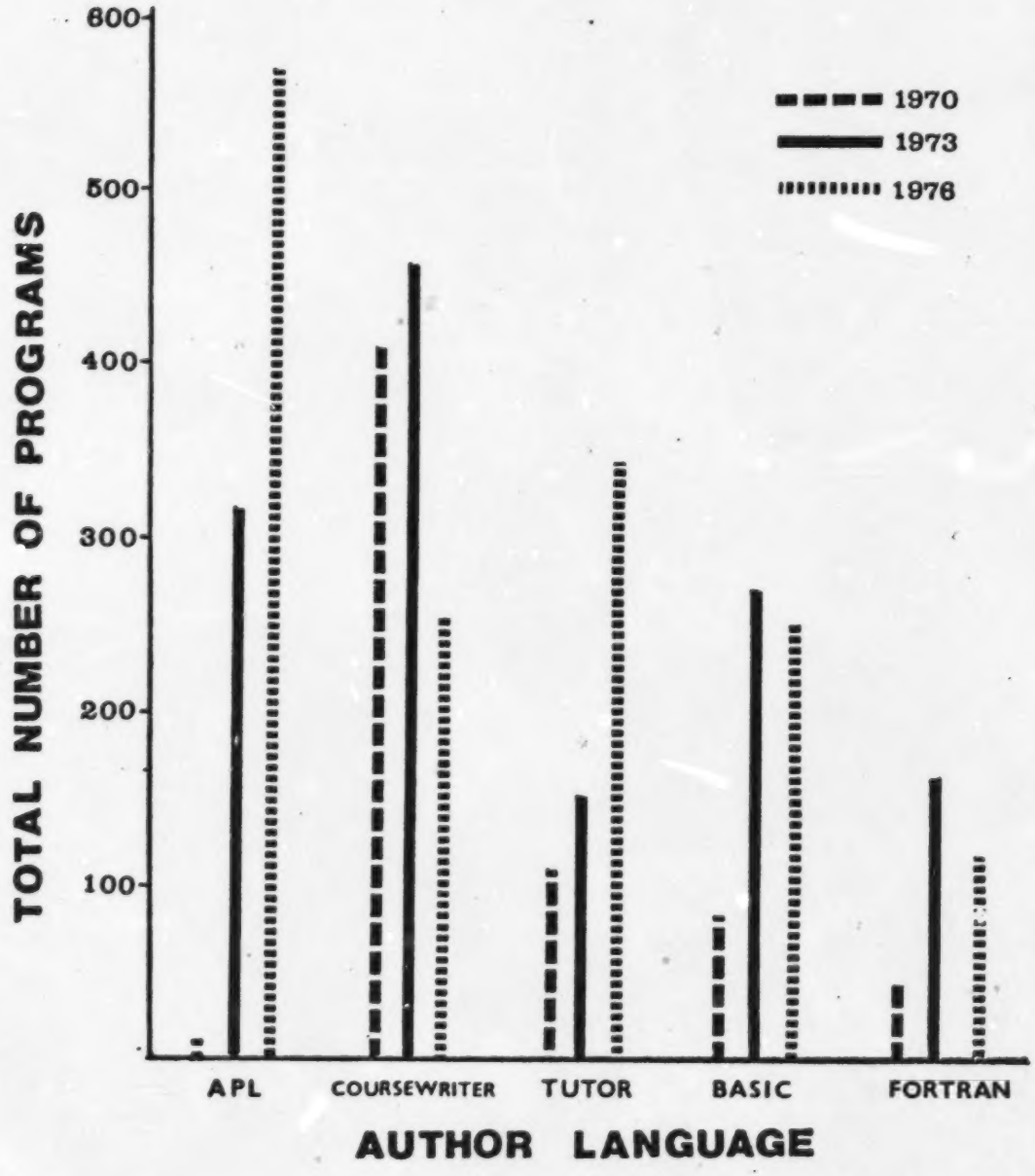

TABLE 3

Total Number of Programs According to CPU.

1970		1973		1976	
IBM 1130/1500/1800	240	IBM 360/370	427	IBM 360/370	802
CDC 1604	180	IBM 1130/1500/1800	395	CDC Cyber	354
IBM 1410/1440	135	CDC 3000/6000	146	Hewlett-Packard	154
IBM 360	120	CDC 1604	144	IBM 1130/1500/1800	83
IBM 7000	85	PDP	129	PDP	82
GE	60	TSS-8	101	CDC 3000/6000	66
PDP	41	GE	99	DEC 10/1000	60
CDC 6000	28	Honeywell	33	Honeywell	47
RCA 70	14	UNIVAC	31	UNIVAC	46
UNIVAC	14	Sigma 7	25	Borroughs 6000	22

TABLE 4

Total Number of Programs According to Source.

1970		1973		1976	
University of Illinois	190	University of Illinois	161	Coast Community College	519
Penn. State University	105	Coast Community College	152	University of Illinois	253
Harvard University	69	Polytech. Inst. Boston	108	Ohio State University	83
Univ. Texas, Austin	67	F.R.P., Heidelberg	105	Purdue University	51
Florida State Univ.	56	Univ. Texas, Austin	84	Buffalo State Univ.	40
Kansas City Sch. Dist.	49	Florida State Univ.	72	F.R.P., Heidelberg	37
G.E. Corporation	35	SUNY	42	University Pittsburg	34
ENTELEK, Inc.	33	University Alberta	41	ENTELEK, Inc.	33
Purdue University	25	G.E. Corporation	37	University Minnesota	30
Montgomery Cty. Pub. Sch.	20	Montgomery Cty. Pub. Sch.	36	University Leeds	27

FIGURE 2. TOYAL PROGRAMS BY INSTRUCTIONAL STRATEGY.